Hydrodynamic, Water Quality, and Ecological Modeling to Assess System-wide Impacts of Restoration Efforts in Coastal Louisiana and Mississippi

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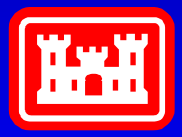

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LCA S&T Program Goals

- **The goal of the LCA Science and Technology Office is to provide project managers and execution teams the best available science and technology support in order to plan, design, construct, and operate coastal restoration projects.**
  - Provide **analytical tools, assemble baseline data and generate recommendations** to reduce scientific uncertainties.
  - **Integrate the roles and resources** of other agencies and partners.
  - Provide for **internal and external technical review** and a systematic approach for coordination with other ongoing and planned related research activities.

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The LCA Science &Technology Office is a partnership between the US Army Corps of Engineers and the Louisiana Department of Natural

DRAFT LCA Decision Framework for Diversions and Restoration Features

- Clear Articulation of Goals and Objectives
- Capturing Lessons Learned from Other Diversions and Coastal Features
- Development of Conceptual Ecological Model for Diversions
- **Development of Analytical Tools to Generate Quantitative and Semi-Quantitative Assessment Results**
- Generation of Multiple Criteria Decision Support System
- Assist in the Development of an Adaptive Management Plan
- Assist in Providing External Technical Review
- Generation of Technical Appendices for Feasibility Reports

Issues Associated With Freshwater Diversions

- A variety of goals and objectives for the diversions – not always complimentary:
  - Improve oyster habitat in Lake Borgne
  - Improve oyster habitat in Bay St. Louis
  - Maintain shrimp habitat
  - Build wetlands, re-establish cypress swamps
  - Maintain water quality
  - Improve or maintain sea grass beds
  - Re-establish historical salinity regimes
- Freshwater diversions can reduce salinity, thus increasing and improving habitat for oysters, but freshwater diversions can also introduce elevated levels of nutrients and suspended sediments, thus increasing productivity

  and potentially building wetlands, but decreasing underwater light, potentially impacting other resources, e.g., a “system-wide” problem

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LCA Concept from CLEAR

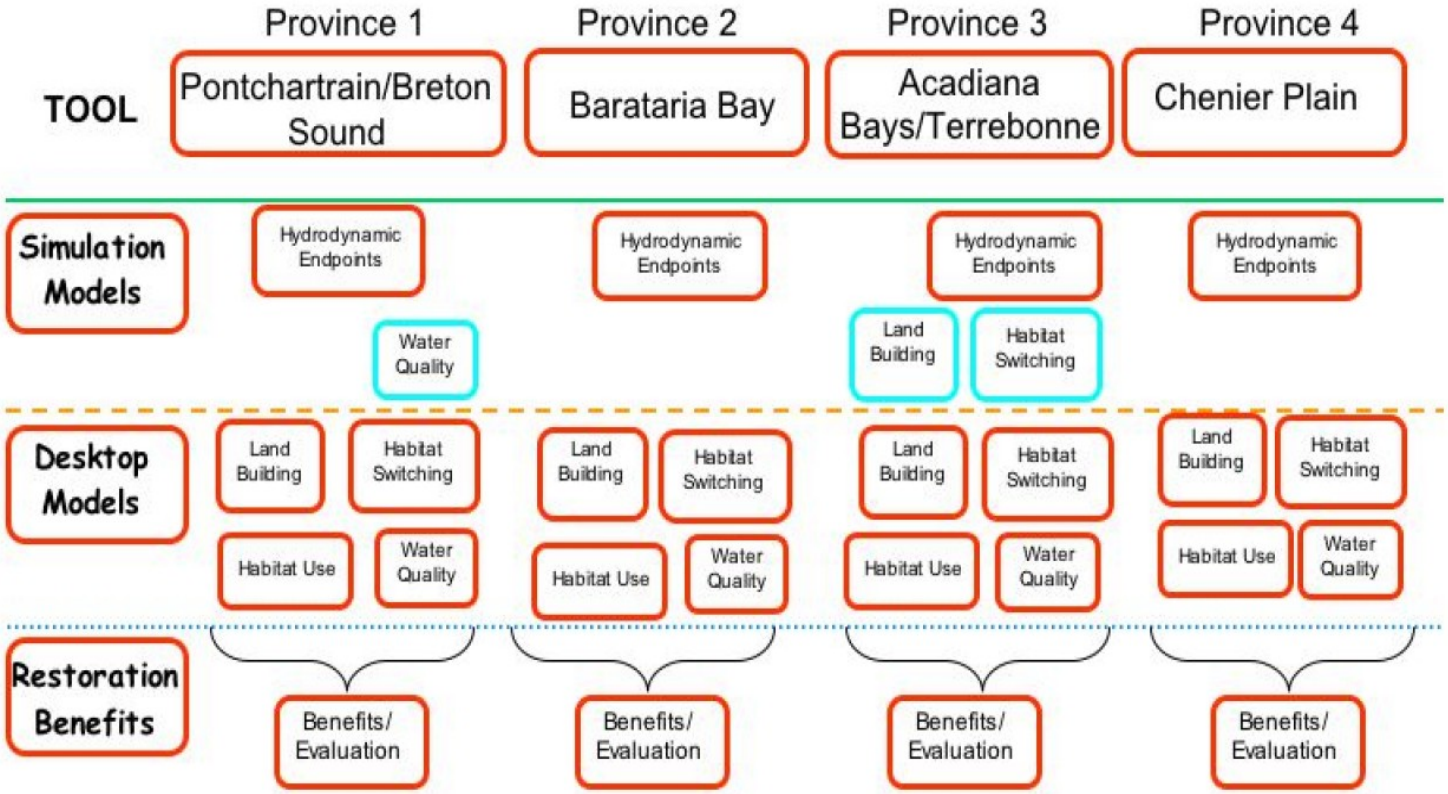


Figure C.2-2. Hybrid of desktop and simulation modeling tools for benefit evaluation.

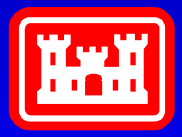
Mississippi Coastal Improvement Program (MsCIP) Hydro-WQ Model

- Objective: Develop Hydro-WQ model to screen alternatives and impacts of freshwater diversions

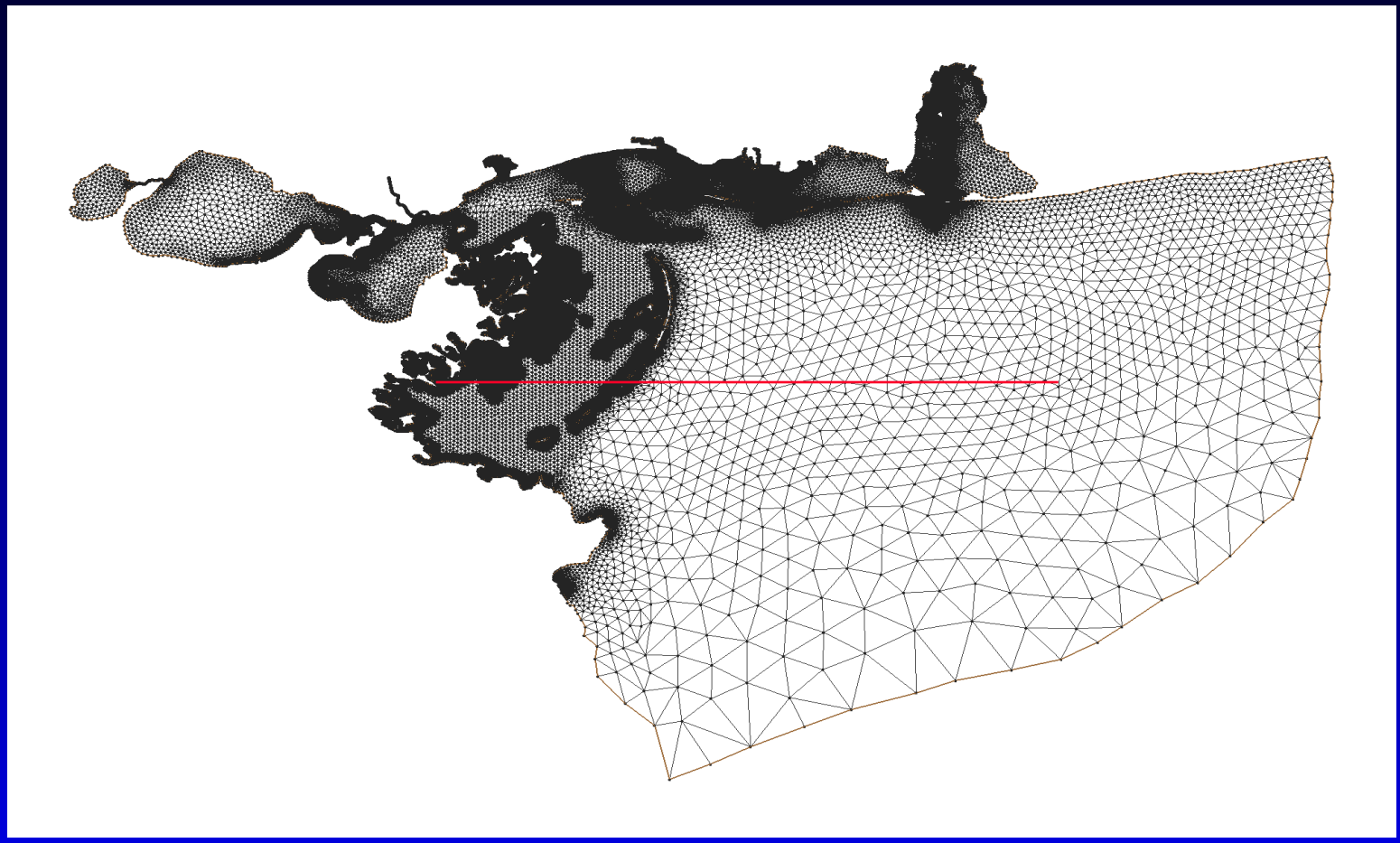
- Developed/applied by ERDC during FY07 for USACE-Mobile District to evaluate impacts of various freshwater diversions on region
- Included salinity and WQ
- Examined diversions of Mississippi River at Bonnet Carre spillway and Violet and Escatawpa River diversion into Grand Bay at the sensitivity level

Modeling Approach

- Required modeling entire region to properly address multiple sources of freshwater
- Derived off-shore water elevations from 2D ADCIRC model of Gulf
- Used CH3D for 3D hydro coupled to CEQUAL-ICM for 3D WQ
- Used 1998 for calibration and scenario testing
- Loadings of nutrients and suspended solids were included in all freshwater flows



ADCIRC Model Domain



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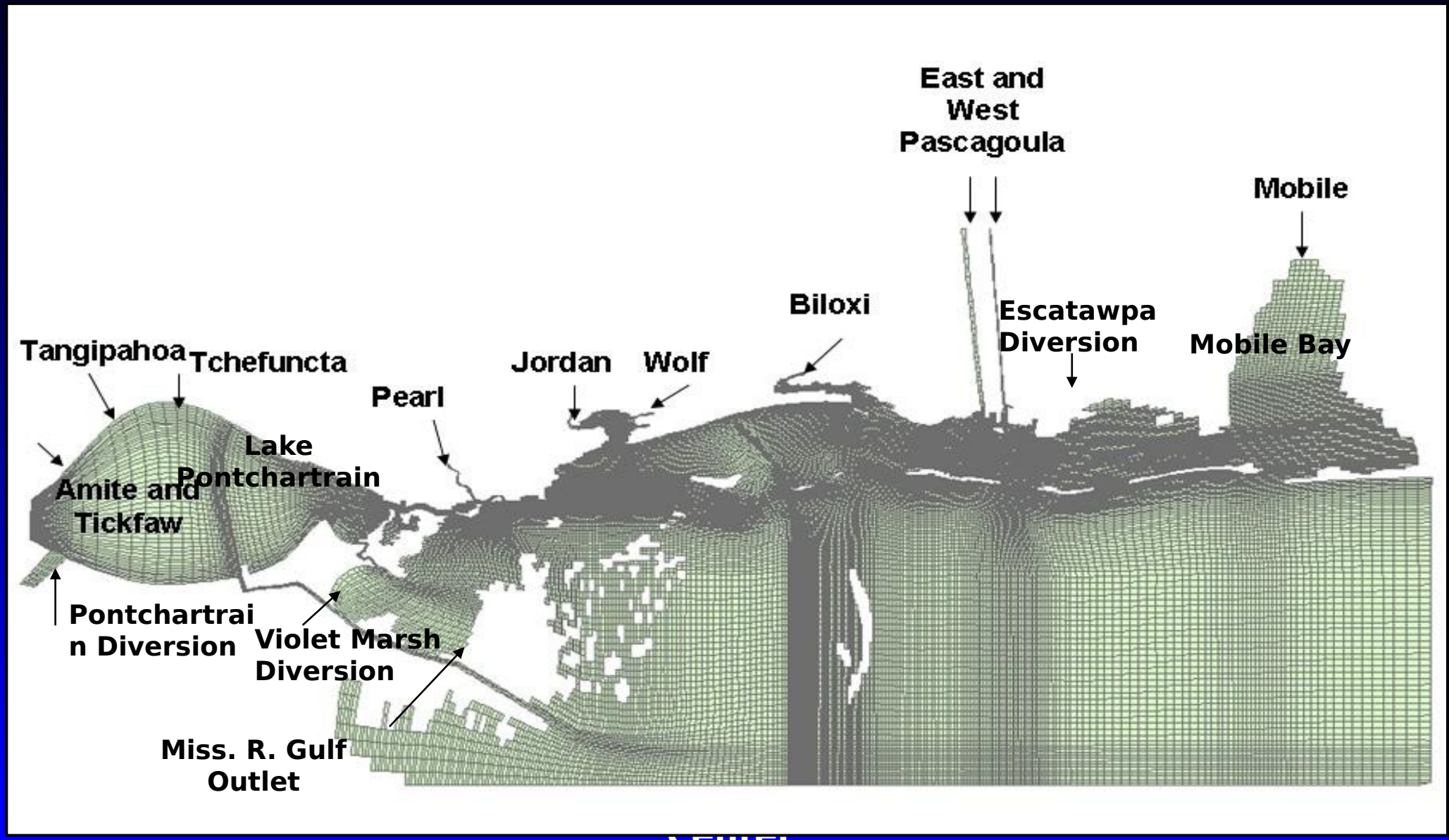
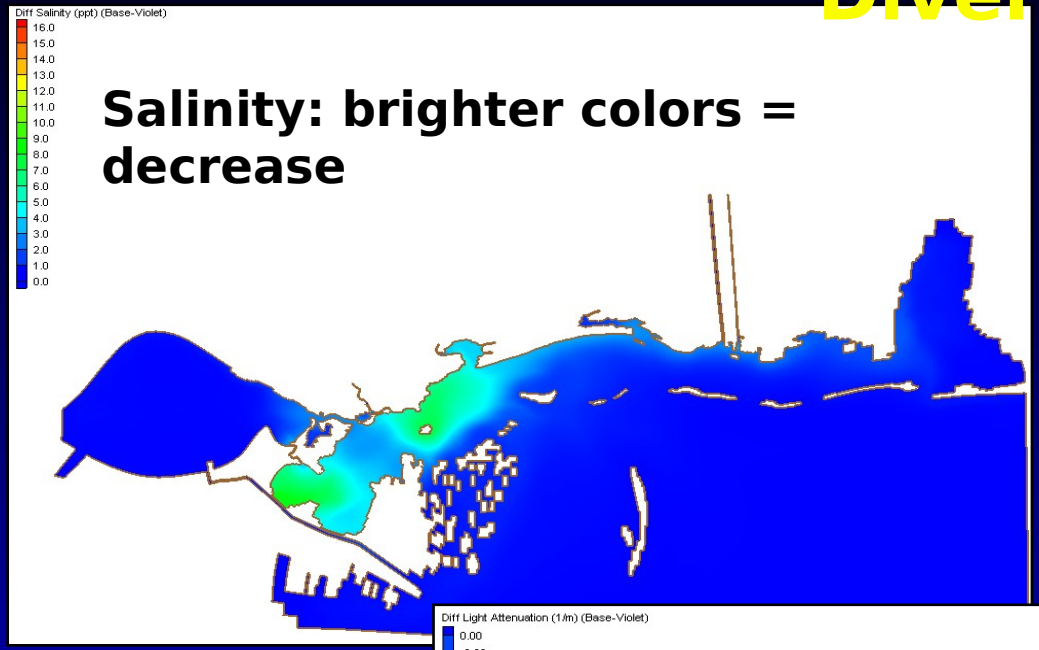
MsCIP Model Grid



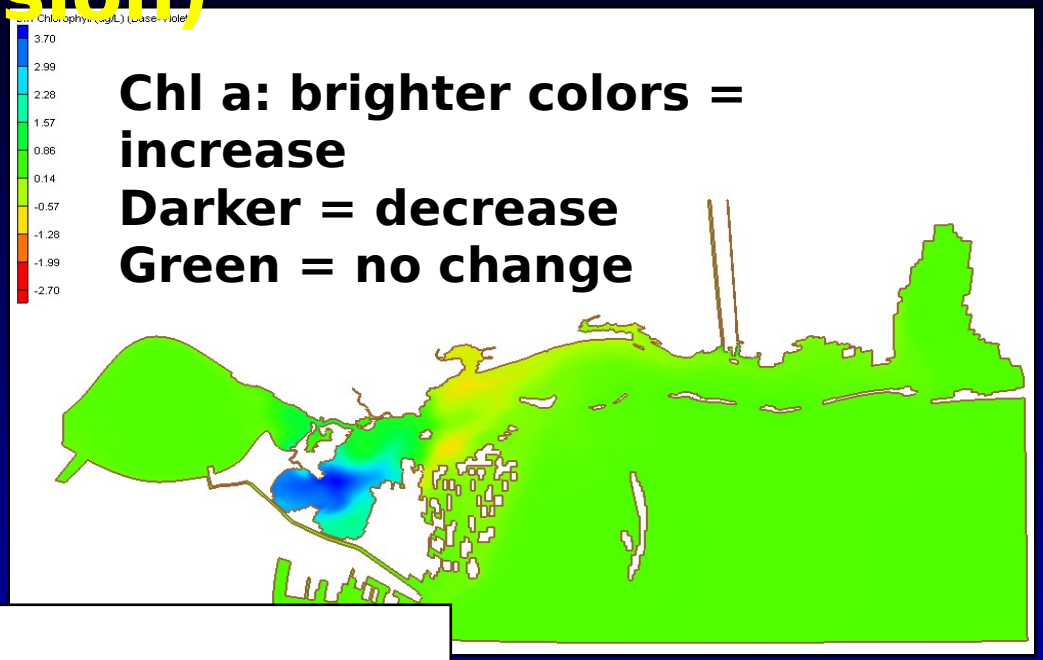
WQ State Variables for MsCIP Model

- Temperature
- Salinity
- Inorganic suspended solids
- Dissolved oxygen
- Phytoplankton carbon
- Total inorganic P
- Nitrate + nitrite N
- Ammonium N
- DOC
- POC
- DON
- PON
- DOP
- POP
- TSS (derived)
- Underwater light (derived)
- Chlorophyll a (derived)
- TOC (derived)
- TKN (derived)

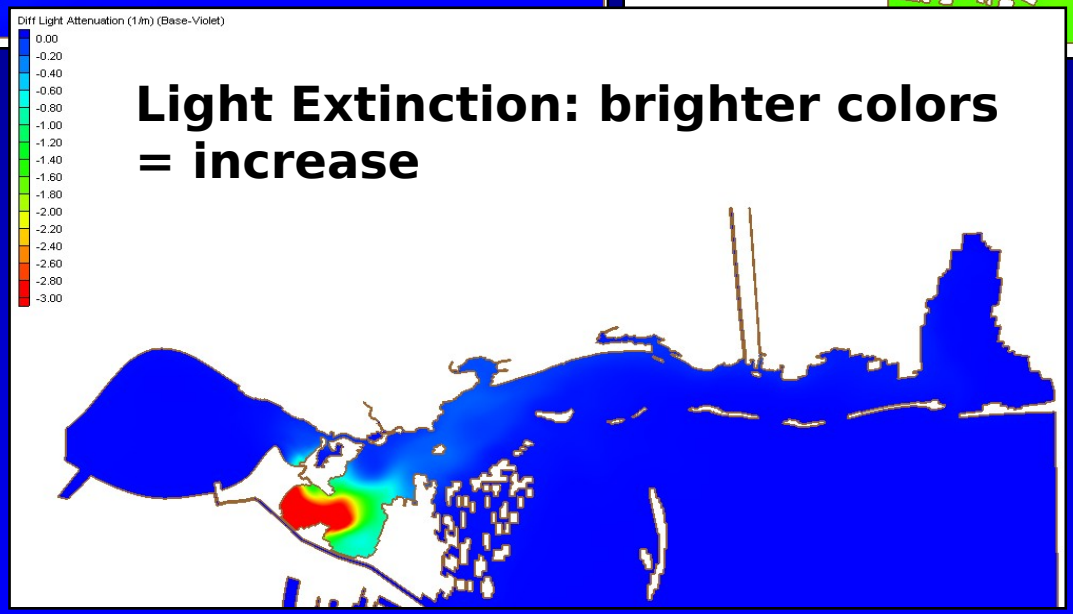
Summer Average Surface Concentration Differences (Base minus Violet Marsh Diversion)



Salinity: brighter colors = decrease



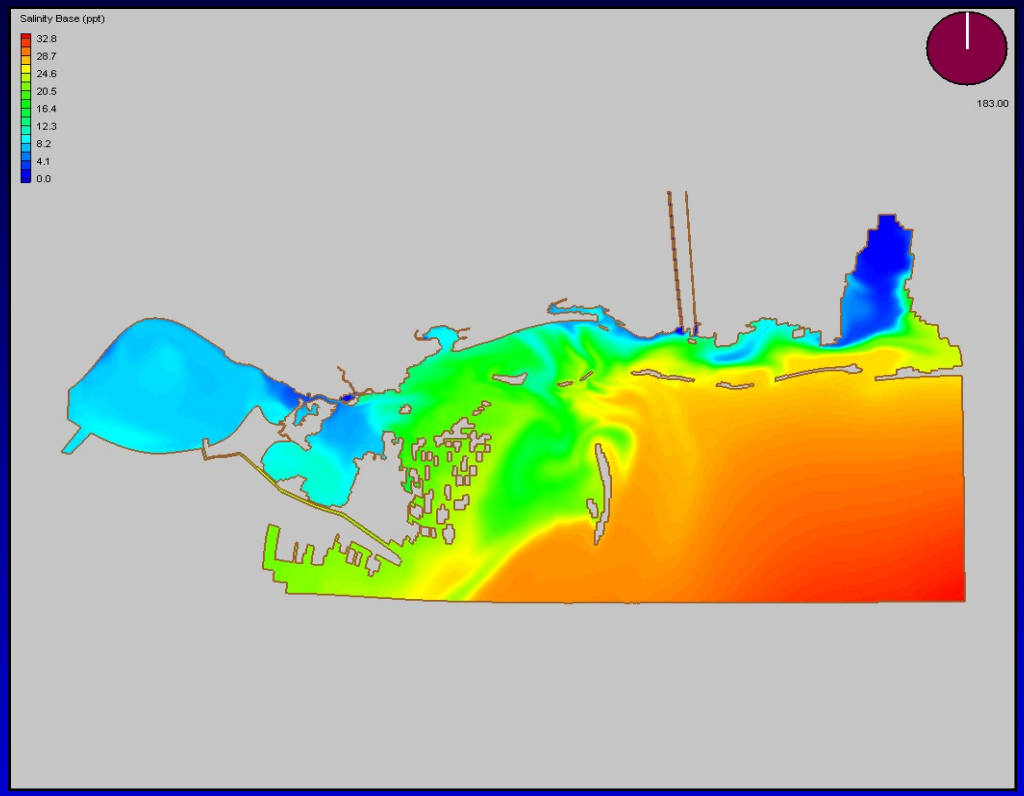
Chl a: brighter colors = increase
Darker = decrease
Green = no change

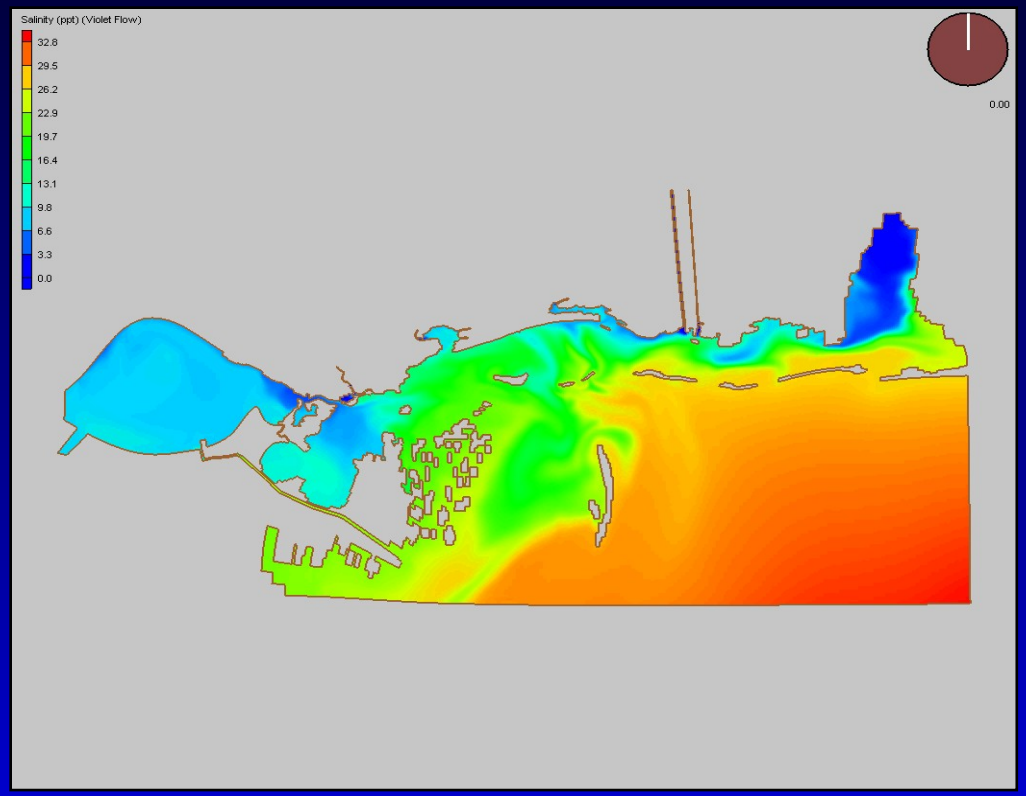


Light Extinction: brighter colors = increase

Salinity Animations for Base Condition and Violet Diversion (7,500 cfs, 180 d)

Click here





Base Condition

Violet Diversion

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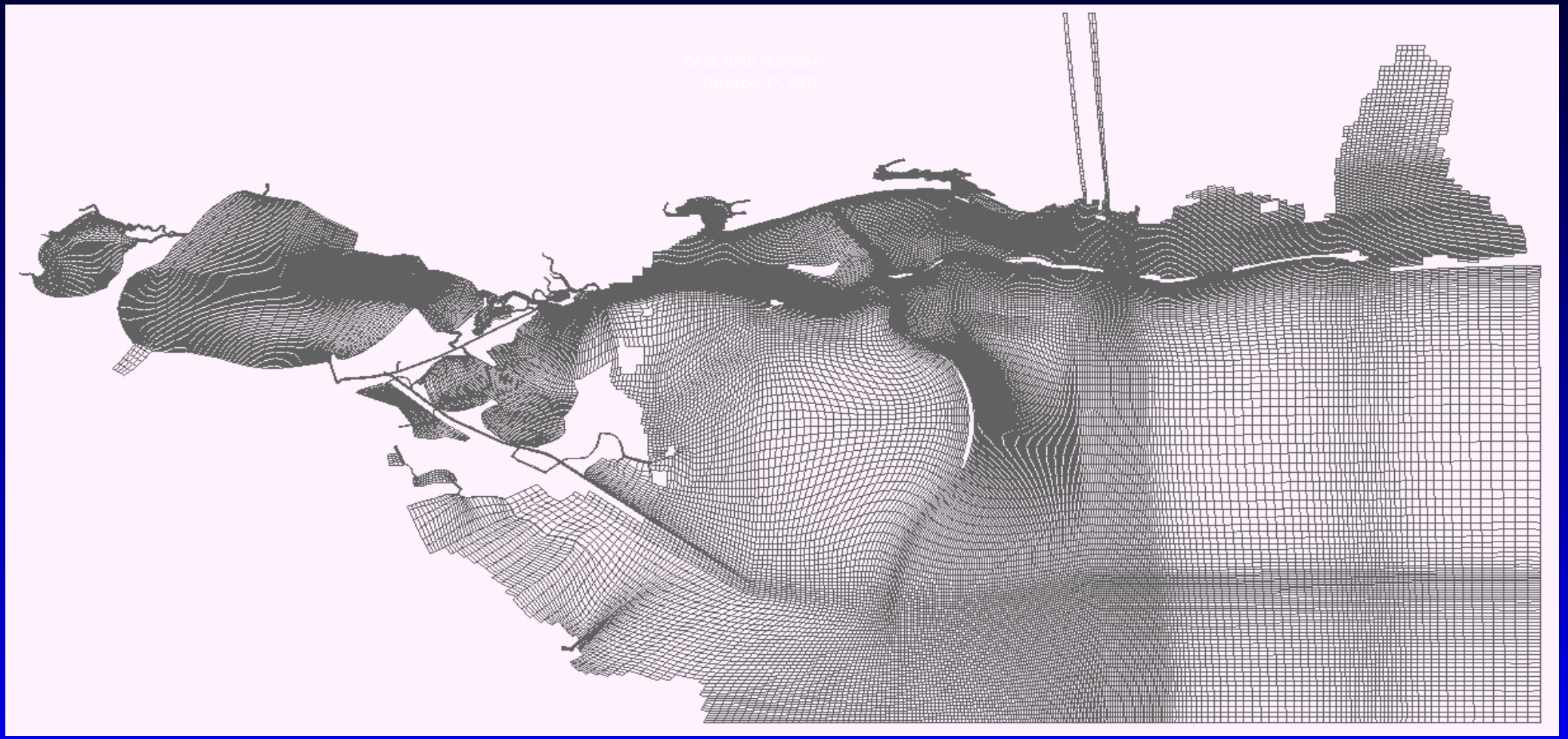
Enhanced MsCIP Grid for LCA



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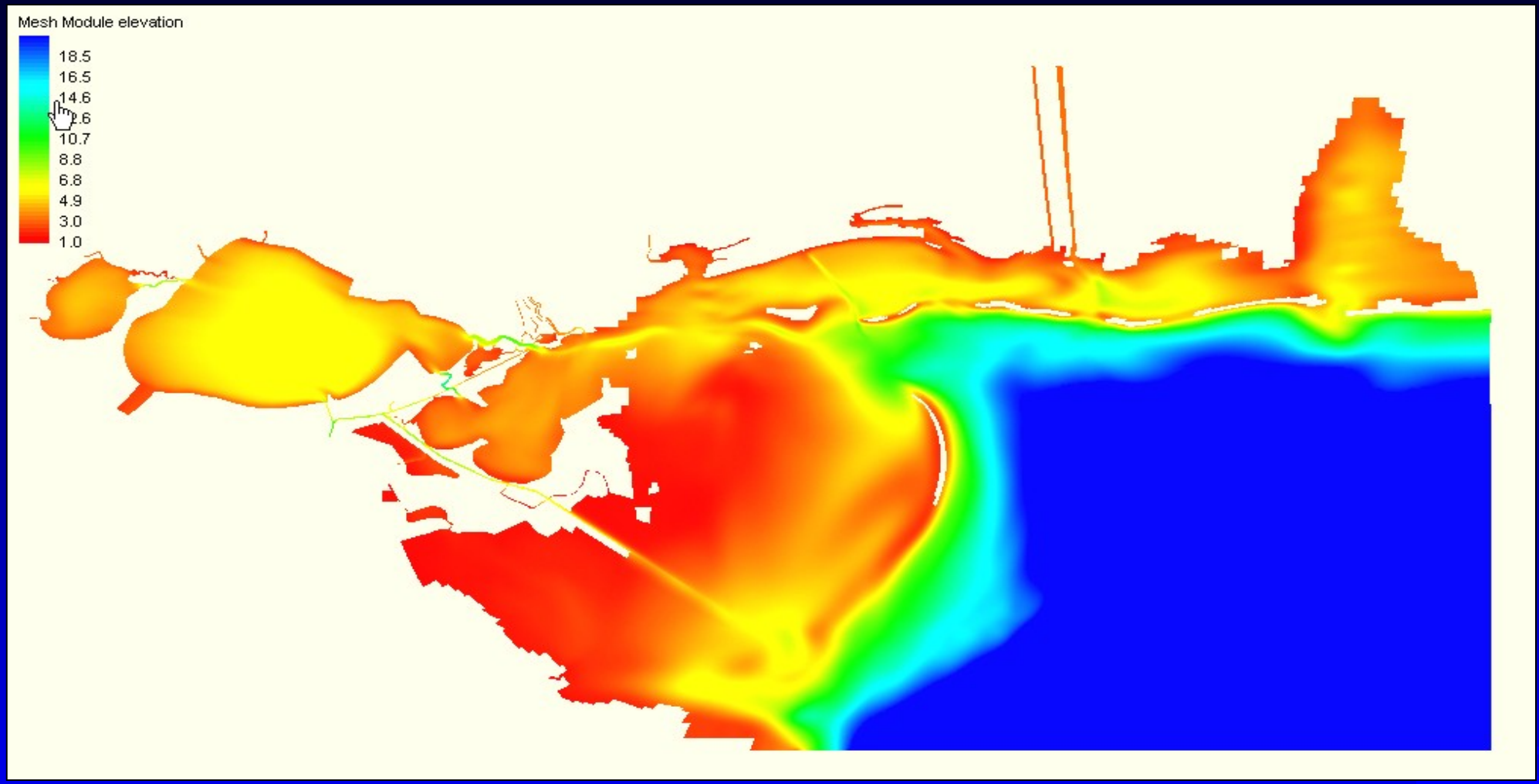
Depth Contours for Revised MsCIP Model Grid



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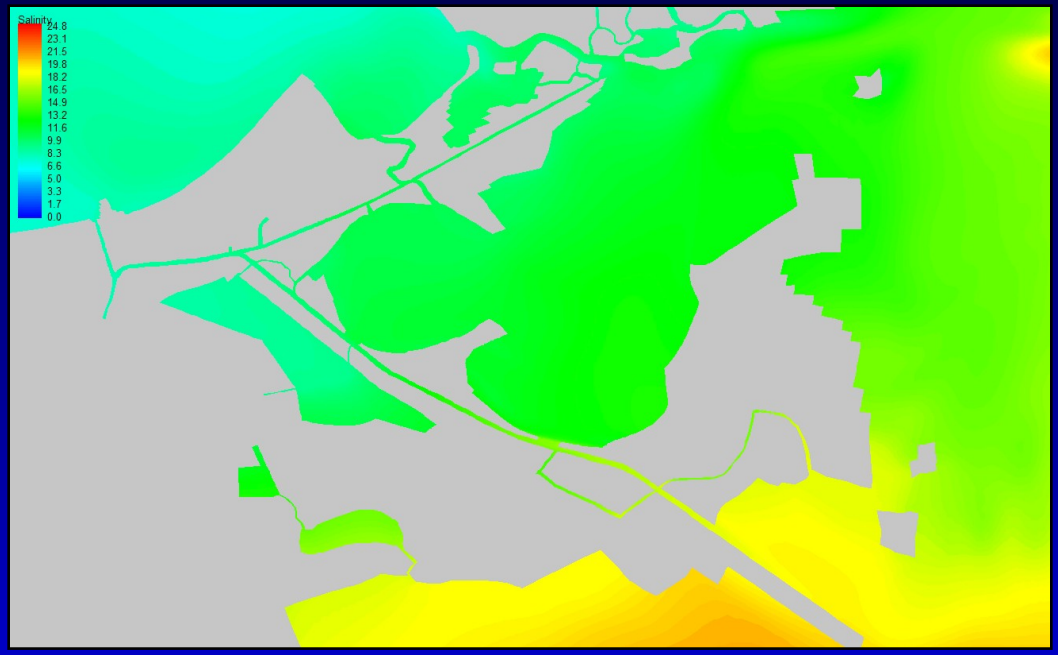
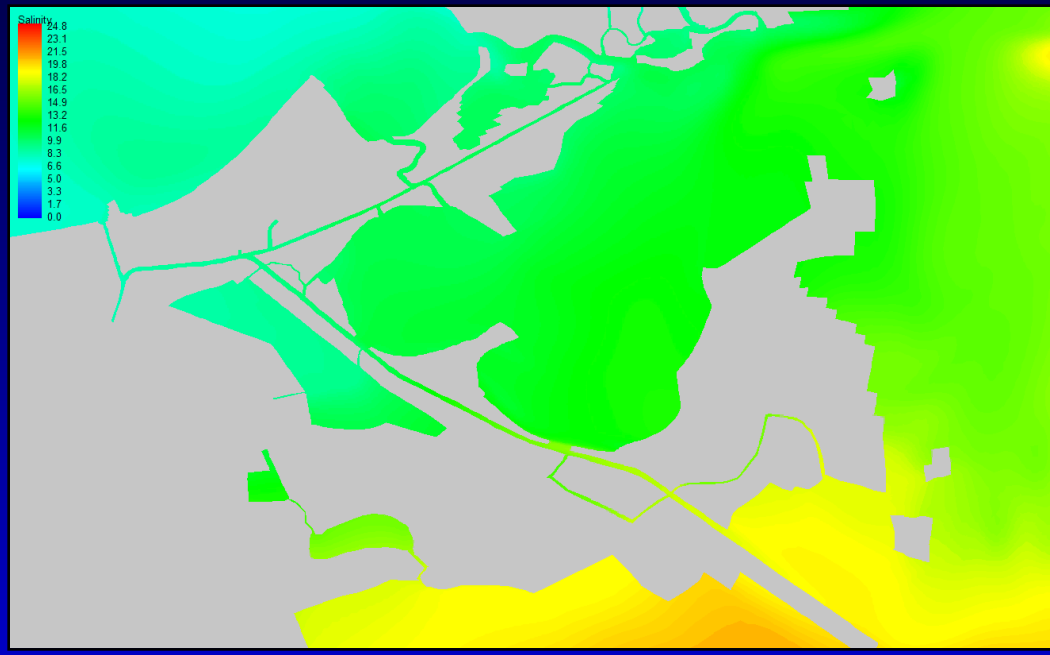
Preliminary Salinity Animations for Base Condition and MRGO Closure

Click here





Base Condition

MRGO Closure

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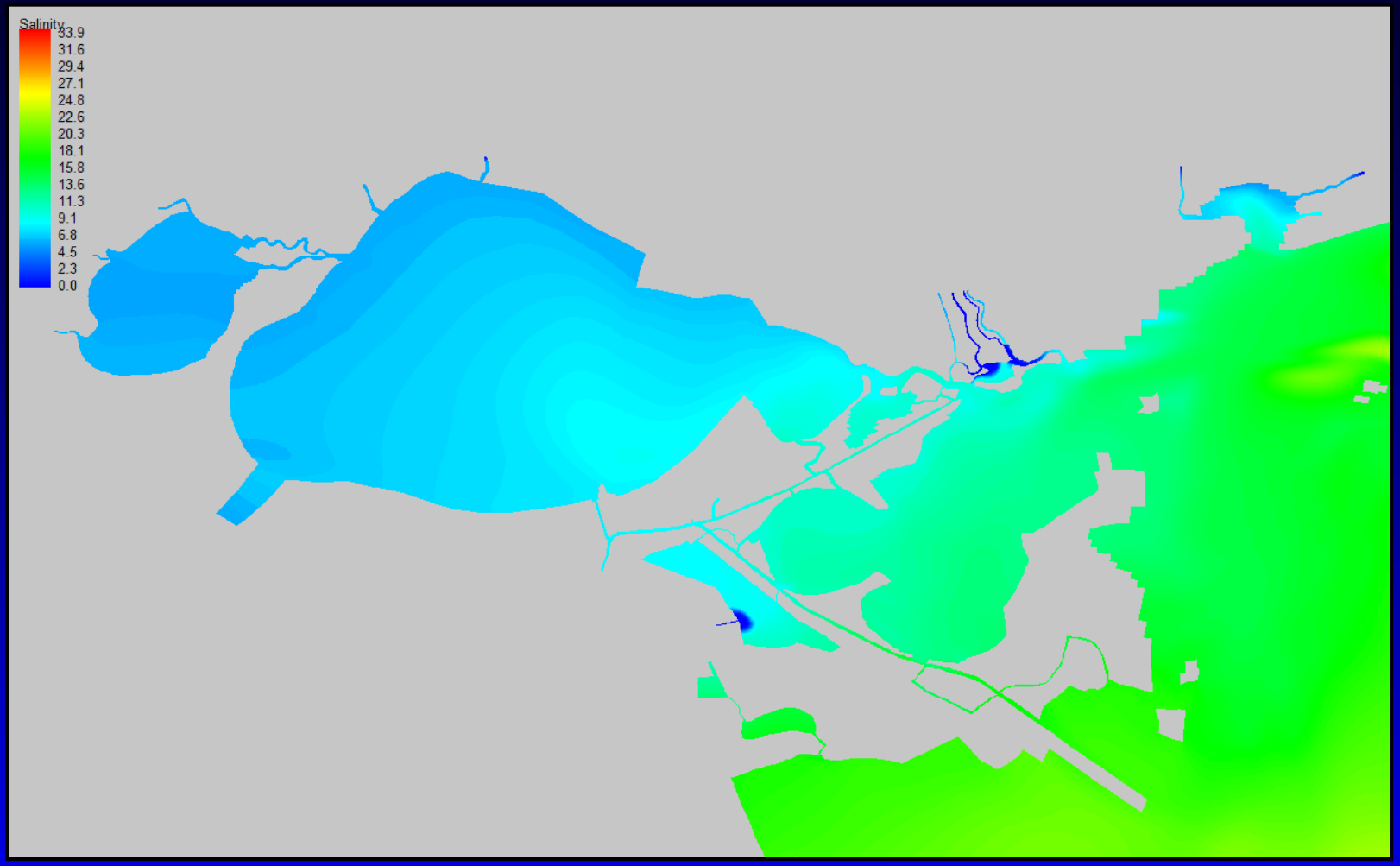
Updated Violet Discharge
(10,000 cfs, 30 days)



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Future Plans & Goals

- Developing decision making framework document - forecast benefits and impacts of alternatives
- Continue refinement of the MsCIP (Violet) model. Complete development of the multi-grid version to decrease model simulation time. Implement an improved and more efficient advective transport routine, spatially varying wind and wave forcing, wetting and drying algorithms and sediment transport capabilities.
- Link MsCIP model to CLEAR models or other ecological models for species impacts

Future Plans & Goals

- Build in vegetation and mechanistic sediment accretion models for land building with feedback to hydro-WQ
- Provide a tool that can forecast long term impacts and benefits of freshwater diversions and other coastal feature restoration efforts, including changes to barrier islands, and changes in circulation due to modifications to channels and inlets